

THE CRAB INDUSTRY IN VENEZUELA, ECUADOR AND MEXICO

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Implications for the Chesapeake Bay Blue Crab Industry

By Michael J. Oesterling and Charles Petrocci

Virginia Sea Grant Marine Advisory Program
Maryland Sea Grant Extension Program

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CONTENTS

Introduction	5
Marine Species of Commercial Importance in South America	7
Carapace Size	7
Geographic Range	9
Habitat	9
Venezuela	11
The Venezuelan Crab Fishery—An Overview	11
Harvesting Techniques	12
Crab Processing	12
Markets for Venezuelan Crab	14
Problems Facing the Venezuelan Crab Industry	15
Long-Range Projections for the Venezuelan Crab Industry	15
Ecuador	17
The Ecuadoran Crab Fishery—An Overview	17
Harvesting Techniques	19
Crab Processing	20
Markets for Ecuadoran Crab	21
Problems Facing the Ecuadoran Crab Industry	22
Long-Range Projections for the Ecuadoran Crab Industry	22
Mexico	23
The Mexican Crab Fishery—An Overview	23
Harvesting Techniques	24
Crab Processing	25
Markets for Mexican Crab	26
Problems Facing the Mexican Crab Industry	27
Long-Range Projections for the Mexican Crab Industry	27
Summary	29
Literature Cited	31



South America

INTRODUCTION

In recent years, Chesapeake Bay crabmeat processors have been besieged by imports into their traditional domestic marketplaces. This comes at a time of rising production costs and local resource fluctuations. Asian and Latin American countries have been significantly contributing to this influx of picked crabmeat. Without some grasp of foreign crab production (present and potential), marketing strategies, and biological parameters of the exploited species, Chesapeake Bay crabmeat producers will continue to lose their share of the domestic crabmeat market.

With the completion of a 1992 overview of a portion of the Asian crab industry (Petrocci and Lipton, 1994), the first step has been taken in providing the Chesapeake Bay crabmeat industry with a better understanding of their global competition. However, more than any other region, Latin America has the longest history of exporting crabmeat to the United States, and yet very little is known about the crab industries in those areas. With a wealth of natural resources and its proximity to the United States, Latin America continues to supply large quantities of crabmeat to the United States. Because of potentially large, untapped crab resources, there is the possibility for even greater volumes of imports from Latin America as the fishery resources in these countries are developed. Additionally, the recently signed North American Free Trade Agreement may make it even easier for products to enter the United States.

Although it may be possible to glean some understanding of the Latin American crabmeat industry from foreign market reports and import data, this does not provide to the Chesapeake Bay crabmeat industries information vital for them to remain competitive in the face of growing imports. It is necessary that an understanding of the complexity surrounding the industry composition be developed for each crabmeat producing country. This should include information on the size of the industry (current and potential), the industry infrastructure, its harvesting and marketing strategies, production capabilities, product form and quality. Armed with this information, Virginia and Maryland crab producers can make better informed business decisions.

In 1991, the National Marine Fisheries Service reported six Latin American countries as exporting crab or crab products into the United States (Steve Koplin, personal communication). These countries were Mexico, Costa Rica, Venezuela, Columbia, Ecuador and Chile. Represented in this list are countries with a long history

of sending crabmeat to the United States (Venezuela), countries new to importing crabmeat (Ecuador) and those with some experience in sending products to the U.S. (Mexico). To gain a better picture of the impact Latin American countries have on the domestic market, it was decided to concentrate upon the established, the upcoming and the new entry into the import business — Venezuela, Ecuador, and Mexico, respectively. Venezuela provides the opportunity to investigate why that country has been successful in sending crabmeat to the United States when others have not (Table 1, page 14). Ecuador is without an established crab fishery (Table 2, page 21). However, preliminary work by Castro et al (1988) indicates that crab resources are present in Ecuador to support a directed fishery. Thus, Ecuador may be used to document the stages of development of the harvesting, processing and marketing of a South American crab industry. Mexico has two regional foci of development, its eastern coast (Gulf of Mexico) and the west coast (Baja California, Gulf of California and Pacific Ocean). The western coast region, in particular the Baja-Gulf of California area, has been experiencing development efforts for its crab fisheries over the past few years, with increasing production (Table 3, page 26).

This project had two main goals: a characterization of existing crab fisheries/production facilities and preliminary identification of potential areas of expansion. In addition, the reasons why successful crabmeat industries had developed in some areas but not others would also be assessed. The field investigations examined exploited species, harvest sites and processing facilities.

MARINE SPECIES OF COMMERCIAL IMPORTANCE IN SOUTH AMERICA

Little is known about the crab resources of Latin America. However, crabs of the genus *Callinectes* are the primary species sought after in all countries visited. In fact, of the 14 known species of *Callinectes*, only two cannot be found at least in one of the countries (Williams, 1974). Some of the potential target species do not reach a size large enough to be considered as a commercial candidate. The following is a listing of the species of *Callinectes* which have been documented to occur in the various regions. Documentation does not necessarily mean that the abundance of the species is sufficient to support commercial harvesting. Comments regarding potential exploitation will follow.

Mexico, East Coast:

C. similis
C. ornatus
C. sapidus
C. exasperatus
C. marginatus
C. rathbunae

Mexico, West Coast:

C. arcuatus
C. bellicosus
C. toxotes

Venezuela:

C. danae
C. ornatus
C. sapidus
C. exasperatus
C. bocourti
C. maracaiboensis
C. marginatus

Ecuador:

C. arcuatus
C. toxotes

Carapace Size

All three of the species found along the Pacific Coast of Mexico and Ecuador can reach carapace sizes sufficient to be considered potential commercial species. Williams (1974) reports the average carapace widths (measured from point to point) as follows:

- C. arcuatus*, males = 4.0 inches, females = 3.1 inches;
- C. bellicosus*, males = 4.7 inches, females = 4.4 inches; and,
- C. toxotes*, males = 6.0 inches, females = 5.7 inches.

Given these sizes, it is no wonder that *C. toxotes* is the target species for exploitation wherever it occurs.

Along the eastern coast of Mexico and Venezuela, *C. sapidus* is the primary target for commercial harvest. However, all the species that occur in these regions, with the exception of *C. similis*, *C. ornatus* and *C. marginatus*, could be considered as possible commercial species, based upon reported carapace widths for male crabs. Williams (1974) reports the average carapace widths (measured from point to point) as follows:

- C. sapidus*, males = 5.6 inches, females = 5.2 inches;
- C. bocourti*, males = 4.3 inches, females = 4.4 inches;
- C. danae*, males = 4.3 inches, females = 3.7 inches;
- C. exasperatus*, males = 4.0 inches, females = 3.8 inches;
- C. maracaiboensis*, males = 4.5 inches, females = 4.5 inches;
- and
- C. rathbunae*, males = 4.4 inches, females = 5.0 inches.

C. sapidus



Geographic Range

Only *C. sapidus*, *C. arcuatus*, *C. bellicosus* and *C. toxotes* will be addressed from this section forward. All information has been taken from Williams (1974), except where noted.

Of all the species, *C. sapidus* has the most extensive range. It is known to occur from northern New England in the United States, south through the Gulf of Mexico and Central America to northern Argentina. Reproducing populations have been established in the Mediterranean and Black Seas, with other reports from Denmark, the Netherlands, southwest France, the Adriatic and Aegean Seas.

C. arcuatus is found along the eastern Pacific coast from southern California to Peru, with reports from the Galapagos Islands. Many specimens in reference collections come from the Gulf of California, and the Mexican states of Sonora and Sinaloa.

The range for *C. bellicosus* overlaps with the northern portion of the distribution for *C. arcuatus*. It is listed as occurring from San Diego, California, to the southeastern extension of Bahia Magdalena in Baja California Sur, around the Gulf of California to Estero el Tasajal, Sinaloa, Mexico (Paul, 1982).

C. toxotes does not occur as far north as either *C. arcuatus* or *C. bellicosus*. Its distribution is from Cabo de San Lucas, Baja California to extreme northern Peru.

Habitat

As one might expect, the habitats of all four species are very similar. All are very tolerate of wide variations in both temperature and salinity. *C. sapidus* has been found in waters of zero salinity to hypersaline lagoons with salinities over 45 parts per thousand (ppt). Likewise, both *C. arcuatus* and *C. toxotes* were collected by Paul (1982) along the Mexican Pacific coast from salinities that ranged from 1 to 65 ppt for *arcuatus*, and 0 - 58 ppt for *toxotes*. *C. bellicosus*, however, was only collected from salinities of 31 to 38 ppt. While *toxotes* was collected over a wide range of salinities, it was most frequently found in salinities of less than 30 ppt, leading Paul (1982) to conclude that it preferred fresher areas than either *arcuatus* or *bellicosus*. He further stated that *C. bellicosus*, with its much narrower range of salinity tolerance, had a preference for fully marine conditions. Gonzalez-Ramirez, et al. (1990) observed that in the Bahia Magdalena, a bay with little fresh water input on the western coast of Baja California Sur, Mexico, *C. bellicosus* comprises 100% of the commercial harvest. Based upon these observations, areas of consistently high salinities would be preferred by *C. bellicosus*, while areas

that experience fluctuating salinities (estuaries, river mouths) would be more likely to have *C. arcuatus* or *C. toxotes*, depending upon location within their respective distributional ranges.

All species can be found over a variety of bottom types, from vegetated to bare mud or sand. Each is capable of burrowing into the surface of the sediment. *C. toxotes* has been characterized as a mangrove swamp crab (Williams, 1974), while *C. arcuatus* is said to prefer fine rather than coarse substrate (Paul, 1982).

Throughout most of Latin America, crabs remain a non-utilized by-catch of other fisheries, primarily trawlers. Regional consumption is limited by either local market availability or no tradition of consuming preprocessed swimming crab meat. In some instances there was evidence of a subsistence utilization. However, there was little utilization at the restaurant level, with the exception of the major hotels/resorts that cater to foreign visitors.

In all three countries visited, harvesting areas are located many miles from crab processing plants. Crabs are delivered to processing plants in trucks, usually unrefrigerated, similar to this one in Venezuela.



VENEZUELA

Venezuela is a country of contrasting cultures and abundant natural resources. One side of the country borders the Atlantic Ocean with a sizable delta system created by the Orinoco River, while on the other side, the clear waters of the Caribbean harbor shallow bays and deep water canyons. Venezuela is the most urban country in South America and also the richest (Brigham Young University, 1993). More than 80 percent of its population of 21 million live in urban areas, with Caracas having over 3.3 million inhabitants. Spanish is the official language, however many people speak or understand some English.



The Venezuelan Crab Fishery— An Overview

Without a doubt the Lake Maracaibo region is the area of greatest crab and crabmeat production. The city of Maracaibo has had a long history of exporting crab products to both the United States and Europe. In fact, the Maracaibo area was the first region of Latin America to begin producing crabs for export to the United States. The entire industry began in 1968 when an oilman from Louisiana noticed large concentrations of crabs around the oil fields of Lake Maracaibo and notified his brother who was in the seafood business. Within the entire Latin American region, the city of Maracaibo holds the greatest concentration of crab processing plants. At least 10 plants are in active production surrounding the city. According to one processor, "all crabs leaving Venezuela come from Maracaibo." Crab harvest and partial processing is occurring further to the south, near Encontrados. All crab plants visited were engaged in crabmeat pasteurization.

The majority of commercial crab harvest sites in Venezuela are centered around Lake Maracaibo. Small fishing villages surrounding the lake provide the workforce of fishermen. The more important harvesting villages are Barranquita, Punto Escondido, La Rita, Cuidad Ojeda, Bachaquero and Orcaro. There is some increasing activity around the Golfo de Venezuela (just outside the entrance to Lake Maracaibo) and in the vicinity of the towns of Coro and Punto Fijo. Some of the crabs harvested from this region are being shipped to processors in Maracaibo. Much further to the east, near the town of Cumaná on the Golfo de Cariaco are areas that have produced some crab products (primarily for local consumption), but further

exploitation is lacking. The extensive delta system of the Orinoco River is suspected of harboring sizable populations of crabs; however, attempts to access these resources have met with failure due to the remoteness of the region and lack of any conveniences.

Harvesting Techniques

Crab harvesting is accomplished by artisanal village-based fishermen, many of whom live in stilt house communities. Small wood boats of approximately 16-18 feet, powered by outboard engines serve as fishing vessels. Square wire mesh Chesapeake Bay-style crab pots are the primary harvesting gear, although some catch may come from small net fishermen. Each crab pot fisherman only works 40-60 pots and harvests only 50 to 100 pounds of live crabs per day. This was cited as a major problem by at least two processing plants. One plant operator went so far as to say that the fishermen were only interested in harvesting enough crabs to supply their daily food and drink. The harvesting sector is heavily subsidized by the processors. Processors provide pots; one processor reportedly has between six and seven thousand pots being fished for him, all of which he provided. In some cases, boats, engines and bait are also provided to the fishermen. Initially the agreement was that the harvesters would repay the processor for the gear. However, over the years repayment has been disregarded, creating a large capital investment on behalf of the processor. Justification was given that this was necessary to keep the fishermen in "corporate dedication" not only to the processor but to the industry itself.

Peak harvest times are the summer months from May until November. There appears to be differential seasonal sex abundance in the harvest, with female crabs being more plentiful during the early part of the season. *Callinectes sapidus* is the only species of crab that was seen at the processing facilities. It is highly probable that *C. maracaiboensis* could have been included within the commercial harvest. Two of the largest processors have noted that over the past 20 years the landings have been declining and the size of the crabs have been getting smaller. According to one processor, he produced 1.5 million pounds of meat in 1989, in 1990 he "produced less," in 1991 "even less," and in 1992, it was "even worse."

Crab Processing

Although the processing facilities are located in the town of Maracaibo, crabs are actually landed many miles away and must be trucked to the processing plants. Because of the intense summer heat, some quality control is sacrificed at the landing sites. Once on-

shore, independent "suppliers" transport crabs to the processing facilities. In most cases, the trucks are not refrigerated and carry no ice. Transit time from harvesting sites to processing plants can exceed 2 hours, resulting in the majority of crabs arriving at the plants dead.

The crab processing facilities in Maracaibo share a striking resemblance to the crab plants of the Chesapeake Bay. Over the past several decades there has been substantial technology transfer between the two regions. The overall processing equipment is identical to that found in Chesapeake Bay crab plants. Likewise, the processing schedule and routine is the same as in the Chesapeake region, with a couple exceptions. A major departure from Chesapeake protocol results because of the fact that most crabs arrive at the processing facility dead or dying. Upon arrival at the larger plants, crabs are immediately immersed in a 200 ppm chlorine bath with ice and left for approximately 30 minutes. This is done in an attempt to quickly reduce any bacterial growth during trans-shipment from the harvesting area. From the chlorine dip, crabs then go to a pressure retort for cooking. The cooking and cooling schedule is

Mike Oesterling (left) discusses the conditions of crabs in a chloride dip with crab processors in Venezuela. In the background are the steam-retorts used to cook the crabs.



essentially what one would find in the Chesapeake, again illustrating the close connection with U.S. technology.

Another difference from the United States crab plants occurs in the picking room. Venezuelan pickers are all dressed in white "uniforms" and wear gauze face masks. It was indicated that this was done in an attempt to prevent any bacterial recontamination of the picked meat that could cause problems upon import to the United States. Meat is picked manually, exactly as is done along the Chesapeake, with meat being graded into backfin (jumbo lump), lump, special, claw and cocktail fingers. Crabmeat is packed into cans (mostly of U.S. origin) and pasteurized using the same pasteurization schedule as followed by Chesapeake crab plants.

Markets for Venezuela Crab

Some product is sold to local markets (whole crabs) and processed meats to regional hotels and restaurants (Caracas and Maracaibo). However, the primary market is as an export product to the United States; the secondary market is European countries. Venezuelan crabmeat has a strong market in the United States, with processing facilities having long-standing relationships with distributors in Florida, California and New York.

Table 1. Crab and crabmeat imports to the United States from Venezuela, 1981 - 1992. Data provided by the National Marine Fisheries Service.

Year	Total Kilograms	Total Value, U.S. \$
1981	172,070	1,485,740
1982	217,738	1,938,550
1983	285,932	2,692,790
1984	387,835	3,890,400
1985	589,213	5,460,600
1986	799,927	7,501,170
1987	623,364	3,647,050
1988	501,743	2,759,180
1989	973,605	6,340,110
1990	875,553	6,964,700
1991	518,040	5,358,970
1992	456,479	6,208,390

Problems Facing the Venezuelan Crab Industry

Venezuela currently is experiencing several problems with their crab utilization.

1. Crab processors report a drop-off of harvest in the Maracaibo region due to over-harvesting, silting in of the lake, pollution, poor recruitment and a lack of interest by region fishermen.
2. The oil industry continues to affect water quality in Lake Maracaibo, which could be a major problem in the future.
3. "New" areas with harvest potential have not been identified.
4. The government provides no support for development of the crab resources outside the Maracaibo region.

Long-Range Projections for the Venezuela Crab Industry

Venezuela has secured a strong market position for its product with United States buyers over the past 20 years. Product form should not change. Pasteurized product will continue to flow into the primary distribution areas of the southeastern and southwestern United States. The future integrity of the Lake Maracaibo crab resources will determine how the core of the Venezuelan crab industry will fare. Because of this situation, new harvest and processing areas must be developed if the Venezuelan crab industry is to expand. However, without either governmental assistance or outside influence, the prospects for near-term expansion outside of the Maracaibo area are poor. The most promising areas are in the eastern portion of the country, near Cumana and approaching the Orinoco delta.



Picking crabmeat in Ecuador. Workers wear gauze face-masks, hairnets and white uniforms in attempts to reduce potential bacterial contamination.

ECUADOR

Located on the Pacific Ocean, Ecuador extends over 950 kilometers along the west coast of South America. Situated on the equator, for which it was named, Ecuador has a tropical climate over most of its country. Even though great strides have been made, Ecuador could still be considered a Third World country. Quito, the capital city, is one of the oldest continuously inhabited cities in the western hemisphere and has a population of 1.2 million (Brigham Young University, 1993). The coastal city of Guayaquil has the largest population at 1.7 million people and is well-known within the seafood industry as the center of Ecuadorian shrimp aquaculture. Spanish is the official language of the country, although many businessmen understand English.

Because of the heavily jungled mountains and highlands, the abundant seasonal rainfall empties tons of nutrients into the deltas and rivermouths found along the coast. This nutrient input creates a very fertile coastal system. The Golfo de Guayaquil is the largest estuary system on the west coast of South America (Castro et al., 1988). It is here that most of the crab harvesting in Ecuador takes place.



The Ecuadoran Crab Fishery— An Overview

The Ecuadoran crab fishery has benefited from a 1988 research assessment initiated by the U.S. Agency for International Development and conducted by personnel from the University of Rhode Island (Castro et al., 1988).

Exploratory fishing was conducted in the Guayas estuary within the Golfo de Guayaquil. Two species of crabs (*Callinectes arcuatus* and *C. toxotes*) were evaluated for potential in developing a directed fishery. This study concluded that the *Callinectes* species were in sufficient abundance to support an artisanal fishery (Castro et al., 1988).

With such a long coastline, one would expect that there would be a number of areas that contain natural crab resources. However, their exploitation potential is controlled by water currents, accessibility and proximity to processing facilities/buyers. Because of these factors, crab harvesting sites are, in fact, somewhat limited. The main harvesting site is within the Golfo de Guayaquil, in the south-

ern portion of the country. Secondarily, commercial harvesting occurs within the Bahia de Caraquez, more to the north. At the far northern end of Ecuador, harvesting primarily for local consumption occurs near the town of Esmeraldas, at the mouth of the Rio Esmeraldas.

Guayaquil is a large industrial city situated on the upper estuary of the Golfo de Guayaquil. The adjacent river outflow is tremendous, with tons of organic debris from the jungle mixed with urban waste pouring into the river. The tidal flow is extremely strong in this system. Presently there is a strong seafood industry infrastructure centered around shrimp aquaculture in the area. Guayaquil is the center of the Ecuador shrimp culture and processing industry. Despite the presence of a well-developed seafood industry and the Castro et al. study, the swimming crab fishery has been slow to develop. This can be attributed to the presence of jobs in the shrimp industry, harvesting difficulties associated with the physical conditions of the estuary, and a historical fishery for another indigenous crab species, *Ucides occidentalis*, the mangrove crab. *Ucides* is a much sought after burrowing crab that is considered by natives to be far superior to other crab species. In the Guayaquil region, restau-

Ecuadoran burrowing crab, *Ucides occidentalis*, "bundled" for sale at a local seafood market.



rants featuring the mangrove crab are as popular as restaurants in the Chesapeake region that highlight the blue crab!

Bahia de Caraquez is another harvesting site also adversely affected by the strong tidal flows of the region. Although some harvesting already occurs in this area, there is potential for further expansion. A large seafood (shrimp) company located near Bahia is actively pursuing expansion of their commercial enterprise and has been aggressive in attempts to establish this area as a productive, cost effective crab harvesting site.

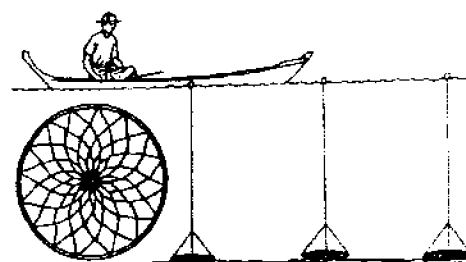
Both the Guayaquil and Manta areas have extensive shrimp culture ponds. Normal Ecuadoran shrimp culture procedures utilize estuarine water sources to fill culture ponds. In this process, swimming crabs (either as larvae or small juveniles) are introduced into the ponds. These crabs have been recognized as both a shrimp culture pest and a potential business opportunity since many shrimp ponds are presently not being utilized. A considerable amount of interest exists in the prospect of culturing swimming crabs in these ponds. However, until basic biological and technological information is developed, crab culturing does not present a viable option for either shrimp pond utilization or crab industry expansion.

To the north near the Columbian border lies the small town of Esmeraldas. This fishing community has the reputation of being a "frontier town," that is of mixed ethnic background and is reportedly not openly friendly to outsiders. It is one area that does consume swimming crabs, selling them in the local market. Over the past few years attempts have been made by crab processors from the south to establish a crab harvesting industry in the area. Although the area has proven productive, one company complained of the uncooperativeness of the fishing community as a reason for failure in expansion. They also expressed concern for the safety of their equipment and fishermen, because of perceived or real threats from the local inhabitants.

Harvesting Techniques

Swimming crabs have been and still are somewhat of a non-utilized by-catch of coastal shrimp trawlers. Standard wire mesh crabs pots are used in some areas, but the preferred method in the main harvesting region of the Golfo de Guayaquil is the lift net. Due to the strong river flow and heavy floating debris, buoyed crab pots become entangled in the debris and are carried away. The lift net, because it is constantly tended, has proved to be the most practical and effective harvest method.

Lift net fishermen average 10 - 15 nets per boat. Baits include trash fish such as a local species of estuarine catfish. Fishermen work



Lift Net in Operation

from small 16 - 20 foot balsawood boats (canoes), sometimes without the aid of outboard motors. One processor actually has a larger motor-powered boat that meets the fishermen in the morning and tows the balsawood boats to the fishing area. At the end of the fishing period, this boat then tows the fishermen back to shore and purchases the day's catch from them.

Crab Processing

Similar to the Venezuelan situation, most Ecuadoran crab processors provide boats, gear, bait and everything else necessary for harvesting, without expectations of being reimbursed. As a result, fishermen form a loose alliance to each processor. However, more than one processor expressed problems in motivating fishermen to become crabbers. This is despite the fact that one processor complained about having to pay \$0.50 per pound to the crabbers (a very high Ecuadoran wage).

As mentioned previously, the primary processing sites are located in Guayaquil and one near the town of Manta. Two crab processing plants were operating in Guayaquil, while one was in Bahia. These plants were patterned after United States plants.

Debris-filled Guayas estuary in Guayaquil, Ecuador can cause harvesting difficulties during periods of heavy flow.



Labor forces were divided, with men doing the cooking and women picking the meat. Crabs were pressure steamed, again following United States guidelines.

A difference from United States procedures was the partial cleaning (backing) of cooked crabs by the cooking force following a brief period of fan-assisted cooling. This was done as a means of eliminating bacterial contamination from waste contact in the picking room. Backed crabs were thoroughly picked using a variety of tools, including scissors. During times of reduced crab abundance, one processor even had the picking force remove meat from the walking legs of the crabs. Gauze face masks are worn continually by the picking force and talking among the standing workers is discouraged. At the picking tables, crabs are placed in ice tubs until picked. Ice tubs are also used to place open cans of meat during picking. Depending upon season and harvest, plants average from 20 to 70 women pickers. One plant in Guayaquil reportedly paid their pickers \$1.80 per day, plus provided transportation to and from the plant, with some food also provided.

Markets for Ecuadoran Crab

The plant in Bahia pasteurizes its product, as does one of the Guayaquil plants, both following United States procedures. One plant in Guayaquil markets its product as a fresh pack. Two or three times per week fresh crabmeat is air freighted from Guayaquil to a seafood broker in New Orleans, Louisiana. Although there is a limited local market for processed product, the primary target is for export to the United States. Ecuadoran crab processors have estab-

Table 2. Crab and crabmeat imports to the United States from Ecuador, 1981 - 1992. Data provided by the National Marine Fisheries Service.

Year	Total Kilograms	Total Value, U.S. \$
1981	2,197	17,188
1982	0	0
1983	653	4,824
1984	249	450
1985	1,635	10,400
1986	0	0
1987	5,764	19,768
1988	3,070	5,979
1989	758	8,410
1990	2,139	7,291
1991	16,220	88,229
1992	109,498	795,537

lished exclusive agreements with United States companies to purchase their production. Currently, most of the Ecuadoran meat is destined to distribution points in Florida and Louisiana. Some interest was expressed in expansion of the United States market distribution network, although one processor indicated satisfaction with their present business relationship with one distributor. Since there are only a few companies engaged in production and export sales, Ecuadoran crabmeat represents only a small percentage of total imported South American product at this time. They are presently seeking to increase product awareness by producing a competitively priced, high quality product.

Problems Facing the Ecuadoran Crab Industry

Ecuador has several problems which it must solve before further developing its crab resources.

1. Strong water currents, heavy seasonal rains and runoff pose serious problems with harvesting techniques.
2. The separation of harvesting sites from processing facilities creates transportation difficulties.
3. A strong infrastructure in the shrimp and other seafood industries competes for skilled (pickers) labor positions.
4. Swimming crabs are not traditionally harvested.

Long-Range Projections for the Ecuadoran Crab Industry

Ecuador has the potential to continue to develop its crab resource industry. Indications are that there is ample resource available in several different estuarine systems to support further exploitation. However, harvesting constraints will continue to plague any development efforts. These constraints will be both natural (floating debris, strong currents, etc.) and sociological (tradition, fear of outsiders). Although the shrimp industry may remain strong, crabs will offer business diversification to those companies already with established marketing structures. The potential for "crab culture" in under-utilized shrimp culture ponds is a big unknown in further development efforts. If proven feasible, crab culture in Ecuador could revolutionize the crab industry and greatly increase the amount of crabmeat originating in South America.

MEXICO

Mexico is about three times the size of Texas, or approximately one-fifth the size of the United States. It has an irregular shaped coastline which offers access to several large bodies of tidal waters. These include the Gulf of California and the Pacific Ocean to the west, and the Gulf of Mexico and the Caribbean bordering the south and east. It shares its northern border with the United States and its southern border with Guatemala and Belize. Though primarily dry and hot with several massive mountain ranges, tropical jungles can be found along the southern coast. Rainy season occurs usually between November and May, although temperature and rainfall may vary depending upon region (Brigham Young University, 1993).

There are over 93 million people in Mexico; Mexico City with a population of 19 million is one of the largest cities in the world. Mexico is an exporter of seafood, with shrimp and tuna being two of its most important export commodities. The United States is Mexico's principal trading partner.

Primarily as a result of its proximity to the U.S., Mexico has a strong infrastructure base in the seafood industry. This developed around the wild-harvest of shrimp from the Gulf of Mexico. There is also an inshore artisanal fishery that targets such species as grouper or yellowtail. Offshore sportfishing has also accelerated considerably over the last decade, with a strong American presence. This has created an opportunity for Mexican seafood products to service the local tourist industry.

An important factor that may have a future impact on the Mexican seafood industry is the implementation of the North American Free Trade Agreement (NAFTA). This could allow for more and easier importation of crabmeat and/or crab products into the U.S. Initiated in 1993, NAFTA and the General Agreement on Tariffs and Trade (GATT) will change many of the traditional ways of doing business with Mexico. NAFTA could stimulate seafood trade into the U.S., while GATT will lower tariffs on products shipped internationally.



The Mexican Crab Fishery— An Overview

Mexico has for the last decade been engaged in developing a crab industry with much of the technology acquired from U.S. crab processors. Mexican crab producers have been involved with foreign investment, joint ventures and up-to-date technology transfer for several years and this is increasing. As a result of these expansion efforts and new investment incentives, there is general knowledge within the U.S. crabmeat industry regarding the development of crab fisheries or processing facilities along the Gulf of Mexico coast and the eastern shore of the Gulf of California (Mexican states of Sonora and Sinaloa). Primary harvesting sites along the eastern shore of the Gulf of California include the towns of Guaymas, Empalme, Los Mochis, Topolobampo, and Guasave. Along the Caribbean/Gulf of Mexico coasts, areas that have experienced crab fisheries interest have been centered around the cities of Tampico, Veracruz and Ciudad del Carmen, as well as other towns along the Yucatan Peninsula coastline. Because of time and funding constraints, field observations for this assessment were concentrated on an area that has not received as much focused attention. The area of concern was the Pacific Coast of Baja California and the western coast of the Gulf of California. The remainder of this section will focus on this region, with comments on other areas when appropriate.

The Peninsula of Lower California, or Baja California, consists largely of rough desert. It is surrounded by water, with the Pacific Ocean to the west and the Gulf of California to the east. The primary crab harvesting area on the western coast is in the Bahía de Magdalena, around the town of San Carlos. Also some crab harvesting activity occurs in the vicinity of La Paz (Bahía de La Paz) on the eastern coast of Baja California. Certainly other harvest sites exist scattered along the Gulf of California and Pacific coasts, but many of these supply only local markets or are a subsistence fishery.

Harvesting Techniques

With a history of wild shrimp capture, crabs have been for some time a by-catch of trawlers. Some of this product is utilized in local markets. Much of this crab by-catch arrives dead and in questionable condition at dockside.

For directed crab harvest, small wooden boats up to 20 feet in length, powered by outboard motors, are the principal fishing craft of coastal crab fishermen. Harvest methods include box traps (pots) and lift nets. Both the lift nets and the box traps are made of fiber netting, with the box traps being reinforced with an iron re-bar frame. Pot

entrances and bait compartments are similar to Chesapeake Bay style pots. Some harvesting equipment is supplied by the buyer/processor. Fishermen will fish an average of 60-70 box traps per boat per day, using primarily sardines or trash fish as bait. There are approximately 100 independent crab fishermen who work out of the Bahia de Magdalena/San Carlos area. About 70 of these fishermen are using pots, while the rest are using lift nets, according to sources at Jaiba Real, a local crab processor. Fishermen are paid an average of 3-4 pesos per kilo (\$0.90-\$1.20 per 2.2 pounds or \$0.41-\$0.55 per pound). The warmer months of June, July, August and September were reported to be the most productive months along both sides of the Baja peninsula.

Crab Processing

On the Baja, some processing plants are located over 50 kilometers (30 miles) from the harvesting sites. This is due to the isolation of the coastline and the poor network of roads connecting sites to processors. For the Bahia de Magdalena fishery, primary processing sites are at Port San Carlos and Conception. Along the eastern side of Baja California, crabs are many times transported to the other side of the Gulf of California for processing at Guaymas, Los Mochis or Guasave.

Mexican crabber displaying large male *C. bellicosus*.



At one harvesting site, crabs were alternately layered with ice and other fish in the back of a closed truck to be trucked and ferried across the Gulf of California to markets on the mainland of Mexico. Many of these crabs arrive in poor condition.

Processing plants in this region have a strong resemblance to Chesapeake Bay crab plants, again reflecting the influence of U.S. involvement. Most crabs brought into plants by truck are packed in ice. Crabs are steamed in U.S. designed (purchased) retorts and allowed to cool overnight in refrigerated rooms. All steaming is carried out by men. Women make up the picking workforce. Picking is done at stainless steel tables, with the pickers wearing face masks, bibs and hairnets. The women stand while picking and only a minimal of talking is permitted. Using knives and mallets, each picker can produce an average of 10 kilos (22 pounds) of picked meat per day. Meats are graded as lump, backfin, special and claw. Pickers are paid for the amount of meat they produce, with the average wage being 2 pesos per kilo (\$0.60 per 2.2 pounds or \$0.27 per pound). Depending upon the season, plants will employ 20-50 female pickers at a time.

Steel cans made in the U.S. are used for packing, although some plastic cups are also being used. One company reported averaging 300 kilos (660 pounds) of pasteurized crabmeat per day. The plant in San Carlos follows U.S. standards for pasteurization for all its production. It appeared that much of their equipment was of U.S. engineering and origin.

Markets for Mexican Crab

Although there is some processed product going into local or regional markets and restaurants (tourist oriented), the main target of

Table 3. Crab and crabmeat imports to the United States from Mexico, 1981 - 1992. Data provided by the National Marine Fisheries Service.

Year	Total Kilograms	Total Value, U.S. \$
1981	39,970	149,218
1982	165,747	267,152
1983	792,719	2,544,770
1984	485,605	1,438,190
1985	18,429	59,576
1986	120,679	288,378
1987	354,306	1,205,670
1988	384,386	1,889,290
1989	559,088	3,056,910
1990	735,769	4,783,850
1991	575,639	4,898,980
1992	560,278	4,460,990

processors is export to the U.S. Mexican crabmeat flows through distributors primarily located in California, Louisiana, Florida and Virginia. Efforts have been made at shipping product to western Europe and this practice may increase.

Problems Facing the Mexican Crab Industry

Mexico, like many developing countries, still faces domestic problems with technology transfer and product packaging. Crabs will remain an underutilized species until new technology coupled with aggressive harvesting and product identification from buyers increases. Mexico does have an overall progressive fisheries management program on all levels (university, research, government); however, crab will continue to lag behind other high value seafood priorities such as shrimp and tuna.

Major problems facing the Mexican crab industry include:

1. A lack of progressive technology transfer directed specifically at the crab fishery.
2. New harvest areas have not been fully exploited. Evidence suggests that other harvest areas (primarily the eastern portion of the Gulf of California) are experiencing problems that point towards over-harvesting.
3. Lack of interest by regional fishermen engaged in other fisheries.
4. Poor market identification by U.S. buyers of Mexican crab-meat. Along this line, there have been reports of inconsistent quality of product originating from existing Mexican plants.
5. A strong shrimp and tuna industry that competes for labor and investment dollars.

Long-Range Projections for the Mexican Crab Industry

Prior to the implementation of the North American Free Trade Agreement, Mexico was already accelerating its crab industry. Fueled partly by American interests, crab exploitation should increase with NAFTA in place. As harvest technology and quality control come on line for this industry, new processing plants may develop regionally, especially in the Gulf of California. Currently there is great pressure by environmental groups to curb the over-exploitation of finfish in both the Gulf of California and Gulf of Mexico. Crab harvesting may be seen as a reasonable fishery alternative or a sustainable growth industry to keep fishermen employed. More products should enter the U.S. through traditional markets and also non-traditional ones such as the emerging ethnic corridor between San Diego, California and Vancouver, Canada.



Statue in Cumana, Venezuela commemorating the Indian fishermen of the region.

SUMMARY

The Chesapeake Bay blue crab industry can expect to see crabmeat from Central and South America for years to come. There are continuing efforts to expand the production capabilities throughout the region, and not just in Venezuela, Ecuador or Mexico. In regards to the three areas of concern for this report, several trends are anticipated, dependent on the country.

In Venezuela, production is expected to remain constant or even decline, without new entrepreneurial involvement or a major commitment from the local government to stimulate interest in areas outside of Lake Maracaibo. Recent reports have indicated another dip in production from the Maracaibo region. Other regions of the country have crab resources, but either have logistic problems or no crab infrastructure or interest in exploiting the local crab populations.

Ecuador presents an enigmatic situation. On the one hand there appears to be sufficient crab resources for exploitation. However, on the other hand, there are environmental, sociological and technology transfer roadblocks to further development. Ecuador crabmeat production is expected to proceed slowly as these hurdles are encountered. It will take a major commitment of time and finances for expansion to be accelerated in the Ecuadorian crab fisheries.

The Mexican crab industry is expected to continue the expansion begun in the late-1980s. This should occur along both coasts. Fueled in part by the proximity to the United States and the focusing of its fishing industry on alternative species, crab resource exploitation should spread to "new" areas along the coasts. Both coasts of the Gulf of California will serve as the anchoring areas for production, with expansion proceeding outward from this center. Harvest expansion along the Gulf of Mexico coast is also expected to continue.

The Chesapeake Bay blue crab industry must continue to look to the south. The vastness of the Central and South American coastlines and expanding global fisheries will make for continued development of the crab resources of these regions. Production efforts are already underway in Brazil, Uruguay and other countries, including those of Central America. To remain competitive, the Chesapeake Bay blue crab industry must be prepared to alter its production, expand marketing into new consumer areas, and possibly develop a unified Chesapeake Bay product to meet the continued imports of South American crabmeat.



Typical crab harvesting boat in Venezuela.

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